CLAIMS

I Claim;

1.) A method for controlling the molecular weight of a polymer by permeating the polymer with a permeant while the polymer has a degree of entanglement greater than zero and is in the solid state, and subjecting the polymer plus permeant blend to a melt processing operation.

2.) The method of claim 1 in which the polymer is selected from the group consisting of ethylene propylene copolymer, high-density polyethylene, high-impact polystyrene, low-density polyethylene, polyamide, polyacrylic acid, polyamide-imide, polyacrylonitrile, polyarylsulfone, polybutylene, polybutadiene acrylonitrile, polybutadiene styrene, polybutadiene terephthalate, polycarbonate, polycaprolactone, polyethylene, polyethyl acrylate, polyetheredierketone, polyethylene sulfone, polyethylene terephthalate, polyethylene terephthalate glycol, polyimide, polyisobutylene, polymethyl acrylate, polymethyl ethyl acrylate, polymethyl methacrylate, polyoxymethylene (polyacetal), polyphenylene ether, polyphenylene oxide, polyphenylene sulfide, polypropylene terephthalate, polystyrene, polytetrafluoroethylene, polyurethane, polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, polyvinylidene chloride, polyvinylidene fluoride, polyvinyl methyl ether, polyvinyl methyl ketone, styrene butadiene, styrene butadiene rubber, cellulose acetate, cellulose acetate butyrate, cellulose acetate propionate, cellulose nitrate, chlorinated polyethylene, chlorotrifluoroethlylene, ethylene acrylic acid, ethylene butyl acrylate, ethyl cellulose, and polymers and copolymers of acrylonitrile butadiene acrylate, acrylonitrile butadiene styrene, acrylonitrile, chlorinated PE and styrene, acrylonitrile methyl methacrylate, acrylonitrile, actylonitrile styrene, acrylonitrile, butadiene acrylonitrile, ethylene propylene diene monomer, and blends or copolymers of the preceding.

3.) The method of claim 1 in which the permeant is selected from the group consisting of; carbon dioxide, nitrogen, oxygen, hydrogen, helium, argon, neon, nitrous oxide, nitric oxide, water, dicumyl peroxide, butyl cumyl peroxide, di-t-butyl peroxide, dimethyl di-t-butyl-peroxyhexane, bis(t-butylperoxy)-di-isopropylbenzene, ethylene glycol dimethacrylate, butylene glycol dimethacrylate, diallyl terephthalate, triallyl isocyanurate, trimethylol propane trimethacrylate, m-phenylene-dimaleimide, pentane, maleic anhydride, silyl peroxide, aluminum trichloride, p-Xylene, trichlorobenzene, toluene, and blends or combinations of the preceding.

4.) The method of claim 1 in which the permeant is selected from a group that is a member of the group consisting of; silanes, siloxanes, polyesters, halogenated monomers, titanates, acid anhydrides, Lewis acid inorganic, aliphatic monocarboxylic acid esters, aromatic monocarboxylic acids, aliphatic dicarboxylic acid esters, phosphates, polyester or polymeric plasticizers, phenols and amines, phosphates, sulfur containing stabilizers, hindered amine light stabilizers. hydroxyphenylpropionates, hydroxybenzyl compounds, alkylidene bisphenols, secondary aromatic amines, thiobisphenols, aminophenols, thiothers, phosphates and phosphonites, metal deactivators, amides of aliphatic and aromatic mono and dicarboxylic acids and their N-monosubstituted derivatives, cyclic amides, hydrazones, bishydrazones of aliphatic and aromatic aldehydes, bis acylated hydrazine derivatives, benzotriazoles, 8-oxyquinoline, hydrazones, acylated derivatives of hydrazinotriazines, aminotriazaoles and acylated derivatives thereof, polyhydrazides, nickel salts of benzyl phosphonic acids, alone, or in combination with other antioxidants or metal deactivators, pyridenethiol tin compounds, phosphorous acid esters of a thiobisphenol and blends or combinations of the preceding.

5.) The method of claim 1 in which the permeant is a solvent for the polymer.

6.) The method of claim 1 in which the permeant is selected from a group consisting of an alkane, an alkene, an alcohol, an ether, a chlorofluorocarbon, and any blends or combinations of any of the preceding.

7.) The method of claim 1 in which the permeant is cyclic butylene terephthalate and the polymer is polycarbonate or a polyester.

8.) The method of claim 1 in which the polymer has been subjected to processing in a Tek Flow processor before the permeation step.

9.) A method for obtaining a polymer of a desired molecular weight and viscosity, comprising the following steps;

i. providing a polymer in the solid state in which the solid polymer has a degree of disentanglement greater than 0%,
ii. providing a permeant,
iii. drying the polymer to an effective level of moisture,
iv. contacting the dried polymer with the permeant for a controlled time and at a controlled temperature and pressure,
v. subjecting the polymer plus permeant to a melt processing operation during which the polymer is melted and the melted polymer is subjected to shear and pressure,

in which method the combination of melt processing temperature, melt processing shear rate, duration of melt processing, level of drying and time, temperature, and pressure of exposure to permeant and the nature of the polymer and permeant are such that the desired combination of molecular weight and viscosity are obtained, and.

10.) The method of claim 9 in which the polymer is selected from the group consisting of ethylene propylene copolymer, high-density polyethylene, high-impact polystyrene, low-density polyethylene, polyamide, polyacrylic acid, polyamide-imide, polyacrylonitrile, polyarylsulfone, polybutylene, polybutadiene

acrylonitrile, polybutadiene styrene, polybutadiene terephthalate, polycarbonate, polycaprolactone, polyethylene, polyethyl acrylate, polyetheredierketone, polyethylene sulfone, polyethylene terephthalate, polyethylene terephthalate glycol, polyimide, polyisobutylene, polymethyl acrylate, polymethyl ethyl acrylate, polymethyl methacrylate, polyoxymethylene (polyacetal), polyphenylene ether, polyphenylene oxide, polyphenylene sulfide, polypropylene terephthalate, polystyrene, polytetrafluoroethylene, polyurethane, polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, polyvinylidene chloride, polyvinylidene fluoride, polyvinyl methyl ether, polyvinyl methyl ketone, styrene butadiene, styrene butadiene rubber, cellulose acetate, cellulose acetate butyrate, cellulose acetate propionate, cellulose nitrate, chlorinated polyethylene, chlorotrifluoroethlylene, ethylene acrylic acid, ethylene butyl acrylate, ethyl cellulose, and polymers and copolymers of acrylonitrile butadiene acrylate, acrylonitrile butadiene styrene, acrylonitrile, chlorinated PE and styrene, acrylonitrile methyl methacrylate, acrylonitrile, actylonitrile styrene, acrylonitrile, butadiene acrylonitrile, ethylene propylene diene monomer, and blends or copolymers of the preceding.

11.) The method of claim 9 in which the permeant is selected from the group consisting of; carbon dioxide, nitrogen, oxygen, hydrogen, helium, argon, neon, nitrous oxide, nitric oxide, water, dicumyl peroxide, butyl cumyl peroxide, di-t-butyl peroxide, dimethyl di-t-butyl-peroxyhexane, bis(t-butylperoxy)-di-isopropylbenzene, ethylene glycol dimethacrylate, butylene glycol dimethacrylate, diallyl terephthalate, triallyl isocyanurate, trimethylol propane trimethacrylate, m-phenylene-dimaleimide, pentane, maleic anhydride, silyl peroxide, aluminum trichloride, p-Xylene, trichlorobenzene, toluene, and blends or combinations of the preceding.

12.) The method of claim 9 in which the permeant is selected from a group that is a member of the group consisting of; silanes, siloxanes, polyesters, halogenated monomers, titanates, acid anhydrides, Lewis acid inorganic, aliphatic monocarboxylic acid esters, aromatic monocarboxylic acids, aliphatic

dicarboxylic acid esters, phosphates, polyester or polymeric plasticizers, phenols and amines, phosphates, sulfur containing stabilizers, hindered amine light stabilizers. hydroxyphenylpropionates, hydroxybenzyl compounds, alkylidene bisphenols, secondary aromatic amines, thiobisphenols, aminophenols, thiothers, phosphates and phosphonites, metal deactivators, amides of aliphatic and aromatic mono and dicarboxylic acids and their N-monosubstituted derivatives, cyclic amides, hydrazones, bishydrazones of aliphatic and aromatic aldehydes, bis acylated hydrazine derivatives, benzotriazoles, 8-oxyquinoline, hydrazones, acylated derivatives of hydrazinotriazines, aminotriazaoles and acylated derivatives thereof, polyhydrazides, nickel salts of benzyl phosphonic acids, alone, or in combination with other antioxidants or metal deactivators, pyridenethiol tin compounds, phosphorous acid esters of a thiobisphenol and blends or combinations of the preceding.

13.) The method of claim 9 in which the permeant is a solvent for the polymer..

14.) The method of claim 9 in which the permeant is selected from a group consisting of an alkane, an alkene, an alcohol, an ether, a chlorofluorocarbon, and any blends or combinations of any of the preceding.

15.) The method of claim 9 in which the permeant is cyclic butylene terephthalate and the polymer is polycarbonate or a polyester.

16.) The method of claim 9 in which the controlled temperature is obtained by subjecting the polymer to microwave radiation or radio frequency radiation.

17.) The method of claim 9 in which the solid polymer is in the form of pellets, and during the steps of being subjected to a vacuum, or contact with the permeant, the pellets are either subjected to a means for agitation by a rotating blade, or is subjected to vibratory motion.

18.) The method of claim 9 in which the steps of drying and permeation are carried out on a rotating carousel, said carousel comprising two or more containers that are rotated in order to carry out the operations of the method in sequence.

19.) The method of claim 9 in which the steps of drying the polymer and contacting the dried polymer with a permeant are carried out in the same extruder barrel as is the melt processing operation.

20.) The method of claim 9 in which the polymer has been subjected to processing in a Tek Flow processor before being contacted with the permeant.

21.) A product made by the process of controlling the molecular weight of a polymer by permeating the polymer with a permeant while the polymer has a degree of entanglement greater than zero and is in the solid state, and subjecting the polymer plus permeant blend to a melt processing operation.

22.) A product made by the process of obtaining a polymer of a desired molecular weight and viscosity, comprising the following steps;

i. providing a polymer in the solid state and which has a degree of disentanglement greater than zero,
ii. providing a permeant,
iii. drying the polymer to an effective level of moisture,
iv. contacting the dried polymer with the permeant for a controlled time and at a controlled temperature and pressure,
v. subjecting the polymer plus permeant to a melt processing operation during which the polymer is melted and the melted polymer is subjected to shear and pressure,

in which method the combination of melt processing temperature, melt processing shear rate, duration of melt processing, level of drying and time and temperature and pressure of exposure to permeant and the nature of the polymer

and permeant are such that the desired combination of molecular weight and viscosity are obtained.

23.) The product of claim 21 or 22 in which the polymer has been subjected to processing in a Tek Flow processor in order to induce the state of having a degree of disentanglement greater than zero.

24.) A method for labeling a polymer that comprises the steps of

i. disentangling the polymer to a degree of entanglement greater than zero,
ii. drying the disentangled polymer,
iii. exposing the material to a permeant that is allowed to diffuse into the polymer,

where said permeant is selected from the group consisting of a fluorescent material, a phosphorescent material, a spin labeled material, a material that can be characterized spectroscopically by an infra red absorption band, and a material that can be characterized by a spectroscopic technique other than infra red absorption.

25.) A labeled polymer made by the process that comprises the steps of

i. disentangling the polymer to a degree of disentanglement greater than zero,
ii. drying the disentangled polymer,
iii. exposing the material to a permeant that is allowed to diffuse into the polymer,

where said permeant is selected from the group consisting of a fluorescent material, a phosphorescent material, a spin labeled material, a material that can be characterized spectroscopically by an infra red absorption band, and a material that can be characterized by a spectroscopic technique other than infra red absorption.

26.) A method for modifying the magnetic or dielectric properties of a polymer that comprises the steps of

i. disentangling the polymer to a degree of entanglement greater than zero,
ii. drying the disentangled polymer,
iii. exposing the material to a permeant that is allowed to diffuse into the polymer,

where said permeant is selected from the group consisting of an ionic material, a magnetically polarized material and a plasma.

27.) A product made by the process that comprises the steps of

i. disentangling the polymer to a degree of disentanglement greater than zero,
ii. drying the disentangled polymer,
iii. exposing the material to a permeant that is allowed to diffuse into the polymer,

where said permeant is selected from the group consisting of an ionic material, a magnetically polarized material and a plasma.

28.) The product of claim 24, 25, 26 or 27 in which the step of disentangling the polymer is carried out in a Tek-Flow processor.